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The attached documents are exact copies of the European patent application described on the following page, as originally filed.

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**Patentanmeldung Nr. Patent application No. Demande de brevet n°**

00202140.0

Der Präsident des Europäischen Patentamts;
Im Auftrag

For the President of the European Patent Office

Le Président de l'Office européen des brevets
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LA HAYE, LE

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# Blatt 2 der Bescheinigung
# Sheet 2 of the certificate
# Page 2 de l'attestation

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Colour cathode ray tube and electron gun

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# Colour cathode ray tube and electron gun

The invention relates to a cathode ray tube as defined in the precharacterizing part of claim 1.

The invention further relates to an electron gun for use in such a colour cathode ray tube.

The colour cathode ray tubes are used, inter alia in colour television receivers and colour monitors.

A colour cathode ray tube is known from WO 97-07523. That document discloses a colour cathode tube comprising an electron gun having a centering cup and a deflection unit. In operation the deflection unit generates an electromagnetic field for deflection the electron beams generated by the in-line electron gun over the display screen. Furthermore, the design of the electron gun and the deflection unit is such that the electron beams are converged on the display screen. The high frequency deflection field induces eddy currents in the centering cup. These eddy currents have a negative influence on the image quality and the sensitivity of the deflection unit. Also the sensitivity of possible scan velocity modulation coils or dynamic convergence coils is reduced. The image quality is amongst other, determined by the convergence of the electron beams on the display screen. Furthermore, the centering cup provides a high voltage contact between the main lens of the electron gun with a conductive layer on the inner side of the cathode ray tube. The conductive layer and the centering cup are overlapping in an axial direction of the cathode ray tube to avoid high voltage discharges, sparks etc. These high voltage problems can be reduced by extending the length of the centering cup. However, longer centering cups increases the eddy currents induced by the electromagnetic field of the deflection unit. To mitigate the electromagnetic effect of the induced eddy currents on the electron beams in the known cathode ray tube the centering cup is provided with four slits. The four slits have been positioned mirror symmetrically with respect to the in-line plane and with respect to a plane perpendicular to the in-line plane through the central aperture. Although these slits reduce the electromagnetic effects of the eddy currents on the electron beam to a certain extend, for a

more shallow colour cathode ray tube the interaction between the electromagnetic field of the deflection unit and the electron gun becomes stronger and the eddy currents increase and the influence on the electron beam is increased. Furthermore switching between lower and higher deflection frequencies, for example between 64 KHz and 95 KHz may introduce substantial changes in the convergence of the electron beams due to the difference in heating of the centering cup and parts of the main lens by the eddy currents induced at the different frequencies.

It is an object of the invention to further reduce the eddy currents in the centering cup.

This object is achieved by a colour cathode ray tube in accordance with the invention as defined in claim 1. The invention is based on the insight that in a centering cup without any slits the currents induced by the inhomogeneous high frequency deflection field are running in circles starting in the second part of the centering cup through the plate of the first part of the centering cup. By the proposed position of the slits the induced eddy currents are reduced and hence the heating up of the centering cup is reduced. Especially, at higher frequencies of the deflection field for example 95 KHz this reduction is significant. The thermal expansion due to the heating of the centering cup and the connected main lens may introduce a mechanical deformation of the centering cup and main lens parts leading to a reduction of the convergence of the electron beams on the display screen. Although in the known cathode ray tube the slits also reduces the eddy currents, these slits don't reduce the eddy currents i.e. the heating of the cup as effective as the slits according to the invention. In the known cathode ray tube the slits are designed to avoid dynamic convergence errors introduced by the eddy currents, whereas in the cathode ray tube according to the invention the slits reduces the eddy currents in such a way that their influence on the dynamic convergence is at acceptable limits and that the heating of the centering cup and parts of the main lens does not substantially affect the convergence of the electron beams. This allows the designers of cathode ray tube to bring the electron gun further in the deflection field thereby creating a more shallower cathode ray tube. A further advantage is that shallower cathode ray tubes can be designed without reducing an overlap between the deflection parts and the electron gun parts thereby avoiding high voltage problems such as high voltage discharges and sparks.

In an embodiment of the cathode ray tube in accordance with the invention the slits interrupt most of the eddy current circles running through the plate of the centering cup and the jacket. The bridges between the first and the second parts are positioned close to the center of the current circles corresponding to positions on a centering cup without any slits where the induced eddy currents are almost equal to zero. In this way the distribution of the eddy currents is changed and the contribution to the total eddy currents is low compared to a centering cup with the slits of the known cathode ray tube.

A further embodiment of the cathode ray tube according to the invention is defined in claim 3. This allows easy manufacturing of the centering cup, the slits can be cut in the walls of the centering cup.

Further embodiments are defined in the dependent claims.

These and other aspects of the invention will be apparent from and elucidated with reference to the embodiments described hereinafter.

In the drawing:

Figure 1 is a longitudinal section of a colour cathode ray tube according to the invention,

Figure 2 is a perspective view of an electron gun as used in the colour display tube of Figure 1,

Figure 3 is a perspective view of a centering cup without slits,

Figures 4A to 4C are respectively a side view, top view and perspective view of a centering cup with slits,

Figure 5 shows in graphical form the dependency of the convergence error $\Delta$ on the position of the slits,

Figure 6 shows a longitudinal section of a further embodiment of a colour cathode ray tube according to the invention and

Figure 7 shows an embodiment of a colour cathode ray tube with an additional coil in front of the deflection unit.

Figure 1 shows an example of a colour display tube of the "in-line" type in a longitudinal section. In a glass envelope 1, which is composed of a display window 2 having a face plate 3, a cone 4 and a neck 5, this neck accommodates an integrated electron gun

system 6 which generates three electron beams 7, 8 and 9 whose axes are located in the plane of the drawing. The axis of the central electron beam 8 initially coincides with the tube axis. The inside of the face plate 3 is provided with a large number of triplets of phosphor elements. The elements may consist of lines or dots. Each triplet comprises an element consisting of a blue green luminescing phosphor, an element consisting of a green luminescing phosphor and an element consisting of a red green luminescing phosphor. All triplets combined constitute the display screen 10. The three co-planar electron beams are deflected by deflection means, for instance by a system of deflection coils 11. Positioned in front of the display screen is the shadow mask 12 in which a large number of elongated apertures 13 is provided through which the electron beams 7, 8 and 9 pass, each impinging only on phosphor elements of one colour. The shadow mask is suspended in the display window by means of suspension means 14. The device further comprises means 16 for supplying voltages to the electron gun system via feedthroughs 17. The colour cathode ray tube also comprises a so-called anode button 18. This anode button 18 is a high voltage lead through which in operation a high voltage is supplied to a third focusing electrode via a conducting layer on the inside on the cone of the envelope.

Figure 2 is a perspective view on an electron gun as used in the display tube shown in figure 1.

The electron gun system 6 comprises a common control electrode 21, also referred to as the G1-electrode, in which three cathodes 22, 23 and 24 are secured. In this example the G1-electrode forms the first pre-focusing electrode of the pre-focusing part of the electron gun. The electron gun system further comprises a common plate-shaped electrode 25, also referred to as the G2-electrode, which forms the second pre-focusing electrode of the pre-focusing part of the electron gun. The electron gun system further comprises a third common electrode 26, also referred to the G3-electrode, which electrode comprises two sub-electrode 26a and 26b (also referred to as the G3a and G3b-electrode). Sub-electrode 26a forms the first focusing electrode, and sub-electrode 26b forms the second focusing electrode. The electron gun further comprises a final accelerating electrode 27, (also referred to as the G4-electrode), which forms the third focusing electrode. All electrodes are via braces 38 connected to a ceramic carrier 39. Only one of these carriers is shown in this figure. The neck of the envelope is provided with electrical feedthroughs 17, electrical connection between the feedthroughs and some of the electrodes are schematically shown in figure 2. The electron gun also comprises at the end facing the display screen a centering cup 28. Said centering cup is usually provided with centering springs 28', of which, for simplicity

only one is shown in figure 2. Said centering springs connect to the conducting layer on the inside of the cone.

Figure 3 shows a perspective view of a centering cup 28. The centering cup 28 is provided with three apertures 29, 30 and 31, for passing the electron beams 7, 8 and 9. The apertures are situated in an in-line plane, in this figure the x-z plane. The centering cup is usually made of non-ferro-magnetic material. The high-frequency deflection field generated by the deflection unit 11 induces in the centering cup eddy currents, which eddy currents reduce the quality of the image. Figure 3 shows by means of arrows a simulation of the intensity of the eddy currents. The eddy currents are concentrated above and below (seen in the y-direction) the central aperture 30.

Figures 4A to 4C are respectively a side view, top view and perspective view of a centering cup 28 with slits 32, 33. The centering cup 28 of figure 4 has a first cylindrical part 41 comprising a plate 43 provided with a central 30 and two outer apertures 29,31 for passing the three electron beams and a second cylindrical part 51. The centering cup 40 is provided with two bridges 53,55 for connecting the first and second parts 41, 51 of the centering cup thereby creating the slits 32,33 between the first and second cylindrical parts 41,51. Within the framework of the invention it has been found that the positions of the bridges with respect to the high deflection magnetic field are important. The dimensions of the respective bridges 53,55 creating the slits between the first and second cylindrical parts 41,51 are such that a first line 67 drawn between a first end 59 of the first bridge 53 to a first end 65 of the second bridge 55 intersects a second line 69 drawn between a second end 61 of the first bridge 53 to a second end 63 of the second bridge 55 and the bisectrix 71 of the intersecting lines 67,69 is substantially parallel to the first direction of the high frequency deflecting magnetic field. Preferably, the eddy currents the slits 32, 33 are positioned substantially parallel with the plate 43 and the lengths of the slits 32,33 are at least 50% of the diameter of the centering cup 28 for an effective reduction of the eddy currents.

Figures 5A to 5C are respectively a side view, top view and perspective view of a centering cup 28 with slits 32, 33. The centering cup 28 of figure 4 has a first part comprising an insert 57 of the main lens and a single plate 43 provided with a central 30 and two outer apertures 29,31 for passing the three electron beams and a second cylindrical part, for example the jacket 51. The plate 43 of the centering cup 40 is provided with tongs 53,55 forming the two bridges with the jacket 51 for connecting the plate 43 and the jacket 51 of the centering cup thereby creating the slits 32,33 between the plate 43 and the jacket 51. The slits 32,33 reduce the eddy currents in the centering cup. Preferably, the slits are positioned

substantially parallel with the plate. The dimensions and positions of the respective bridges 53,55 creating the slits 32,33 between the plate 43 and the jacket 51, are such that a first line drawn 67 between a first end 59 of the first bridge 53 to a first end 65 of the second bridge 55 intersects a second line 69 drawn between a second end 61 of the first bridge 53 to a second end 63 of the second bridge 55 and the bisectrix 71 of the intersecting lines 67,69 is substantially parallel to the first direction of the high frequency deflecting magnetic field. Preferably, the lengths of the slits 32,33 are at least 50% of the diameter of the centering cup 28 for an effective reduction of the eddy currents.

Figure 6A to 6C shows the effect of the slits on the convergence error. When a convergence error occurs the outer electron beams do not coincide on the display screen with the central electron beam, which non-coincidence causes a distortion of the image displayed on the screen. The convergence errors of the cathode ray tubes due to the heating of the centering cup and parts of the main lens can be compensated for a predetermined frequency of the magnetic field generated for the line deflection. For example, the convergence error can be compensated for by means for generating a biasing magnetic field to compensate the convergence error. E.g. a ring of hard magnetic material in the centering cup. This ring is positioned in the centering cup. During the manufacturing of the cathode ray tube in a first step the convergence error for the predetermined frequency is measured for a cathode ray tube without the biasing magnetic field of the ring. Then in a subsequent step the biasing magnetic field strength of the ring is calculated for compensation of this convergence error and the hard magnetic material of the ring is magnetized for providing this calculated biasing magnetic field strength. However, when the frequency of the high frequency deflection field is changed to a second predetermined frequency the convergence error of the cathode ray tube may be increasing to a higher value due further thermal expansion of the ring and main focus parts at increasing temperature corresponding to higher eddy currents related to the second higher frequency. For example, when the cathode ray tube is switch from a low to a high resolution mode. In this example the first frequency of the high frequency deflection field in the low resolution mode is 44 kHz and the second frequency of the high frequency deflection field in the high resolution mode is 95 kHz. Figure 6A, 6B en 6C show the non-convergence of the electron beams on the display screen as a function of time after the display has been switched from the first to second mode. In Figure 6A,6B and 6C the convergence error is given as an absolute value in millimeter. Figure 6A shows a graph of the convergence error of a 19" cathode ray tube with an electron gun having a relatively long centering cup with a length of 13 millimeter with two slits according the position as

described with reference to Figure 4. The dots in figure 6A, through which, for guidance of the eye, full line 61 is drawn, are the results of measurements for a centering cup having a length of 13 mm and two slits. In this example the width of the slits is 0.1 mm and the width of the bridges is 5 mm and configured according to Figure 4.

Figure 6b shows a graph 62 of a convergence error of a cathode ray tube with an electron gun with a relatively long centering cup with a length of 13 millimeter without slits. Figure 6C shows a graph 63 of a conventional cathode ray tube with an electron gun with a conventional centering cup with a length of 6.5 millimeter.

From Figure 6A and Figure 6B can be seen the position of the slits reduces the eddy currents significantly and the convergence error is reduced from 0.15 mm to 0.09 mm and may reduced further to 0.05 millimeter.

Figure 6C shows a graph of the convergence error of a conventional cathode ray tube and a conventional centering cup with a length of 6.5 millimeter. The convergence drift of the cathode ray tube with the new centering cup approaches the convergence drift of the shorter conventional cup. The new design allows a more shallow design of the cathode ray tube while problems with high voltage and loose particles are reduced.

Figure 7 shows a cathode ray tube for which the invention is particularly advantageous. Around the neck, in front of the deflection unit, an additional coil 61 for generating an alternating electro-magnetic field is provided. Such a coil can be for instance a Scan-Velocity Modulating coil. When such additional fields are used, the eddy currents in the centering cup are particularly strong and can be reduced significantly with the centering cup as described above.

CLAIMS:

1. A colour cathode ray tube comprising a display screen, an electron gun for generating three electron beams, said electron beams being directed to the display screen and deflection means for generating a magnetic field in a first direction for deflecting the electron beams across the display screen, said electron gun comprising a centering cup having a first part provided with a central and two outer apertures for passing the three electron beams and a second part extending in the direction of the display screen for avoiding sparks, the centering cup being provided with slits for reducing the effects of eddy currents, characterized that the centering cup comprises a first bridge and a second bridge creating the slits between the first and second parts such that a first line drawn between a first end of the first bridge to a first end of the second bridge intersects a second line drawn between a second end of the first bridge to a second end of the second bridge and the bisectrix of the intersecting lines is substantially parallel to the first direction.

2. A colour cathode ray tube as defined in claim 1, characterized in that the first part comprises a plate provided with the central aperture and the two outer apertures, and the slits being substantially parallel with the plate.

3. A colour cathode ray tube as defined in claim 1, characterized in that the lengths of the slits are at least 50% of the diameter of the centering cup.

4. A colour cathode ray tube as defined in claim 1, characterized in that the second parts comprises a circular symmetric jacket.

5. A colour cathode ray tube as defined in claim 1, characterized in that the first and second parts comprises respectively a circular symmetric jacket.

6. A colour cathode ray tube as defined in claim 1, characterized in that the centering cup is provided with a ring comprising a ferro-magnetic material.

7. A colour cathode ray tube as defined in claim 1, characterized in that the width of the slit is about 0.1 mm.

16.06.2000

ABSTRACT:

The invention relates to a color cathode ray tube. Furthermore, the color cathode ray tube comprises a display screen, an electron gun for generating three electron beams, wherein the electron beams being directed to the display screen. Also deflection means are present for generating a magnetic field in a first direction for deflecting the electron beams across the display screen. The electron gun comprises a centering cup having a first part provided with a central and two outer apertures for passing the three electron beams and a second part extending in the direction of the display screen. The centering cup of the electron gun is provided with two bridges creating the slits between the first part and the second part of the centering cup such that a first line drawn between a first end of the a bridge to a first end of the other bridge intersects a second line drawn between a second end of the first bridge to a second end of the other bridge and the bisectrix of the intersecting lines is substantially parallel to the first direction in order to reduce the eddy currents in the centering ring.

Fig 4C

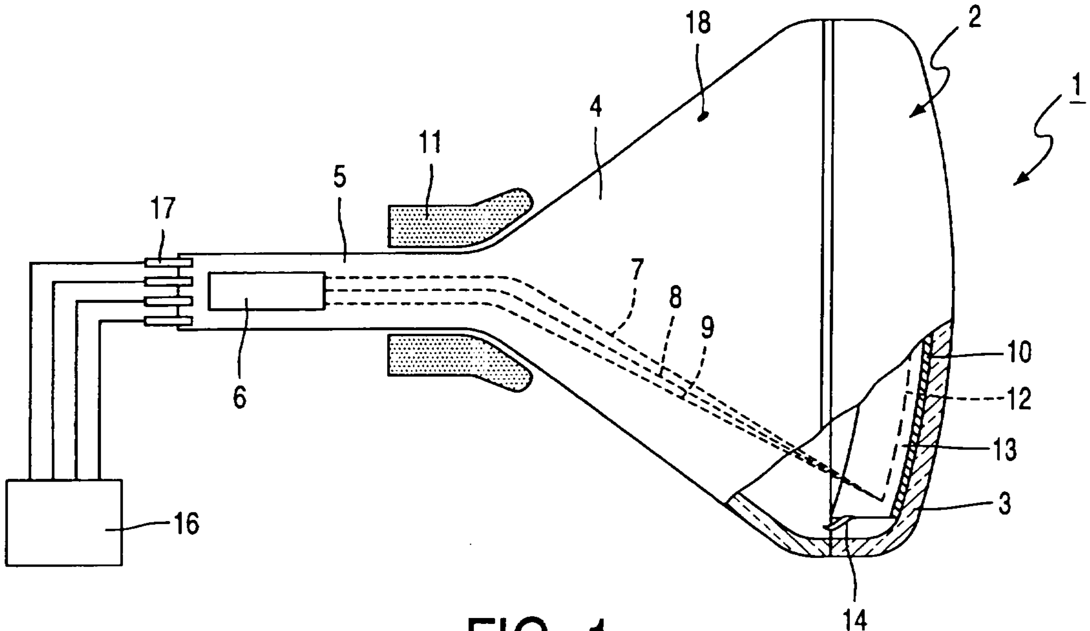
18
2
1
4
11
5
17
7
8
9
10
6
12
13
3
16
14

FIG. 1

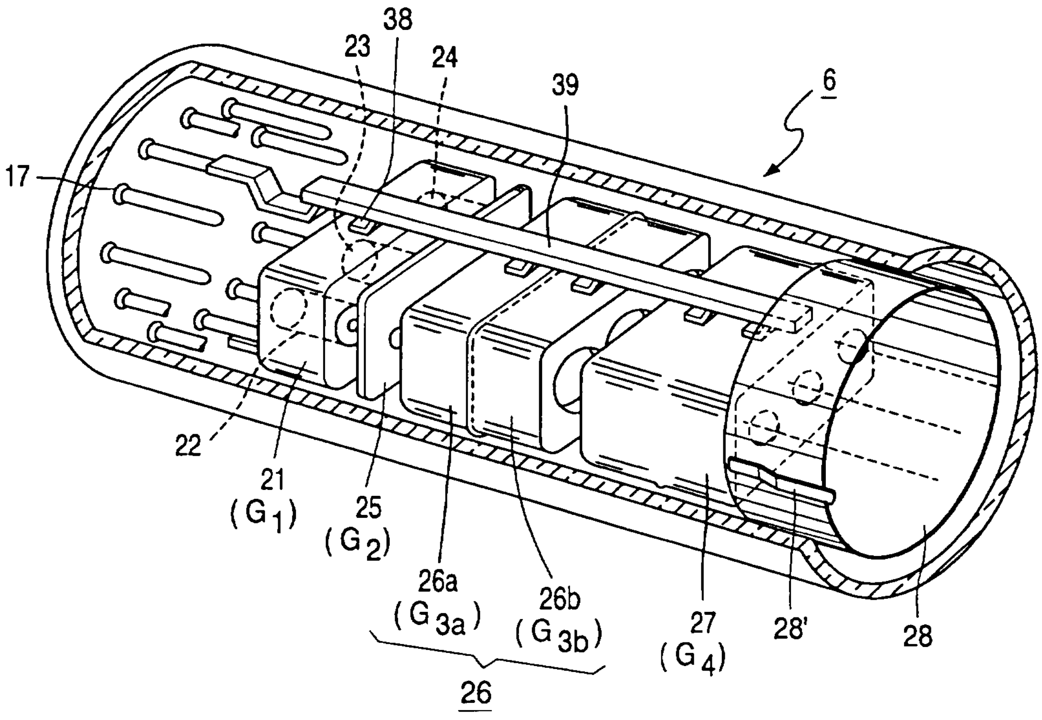
38
23
24
39
6
17
22
21
(G1)
25
(G2)
26a
(G3a)
26b
(G3b)
27
(G4)
28'
28
26
(G3)

FIG. 2

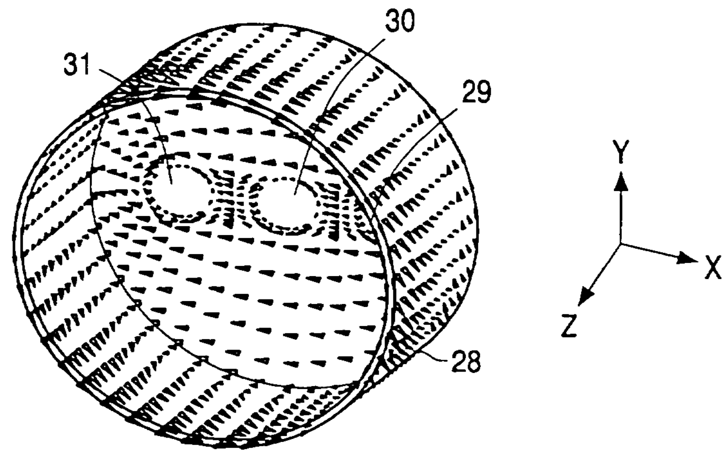


FIG. 3

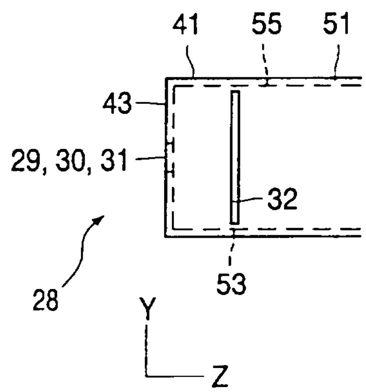


FIG. 4A

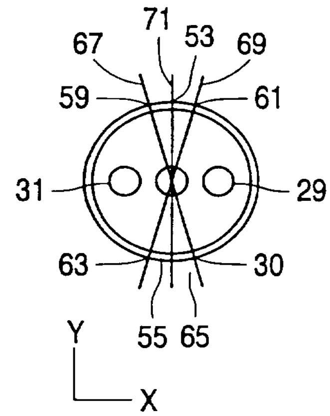


FIG. 4B

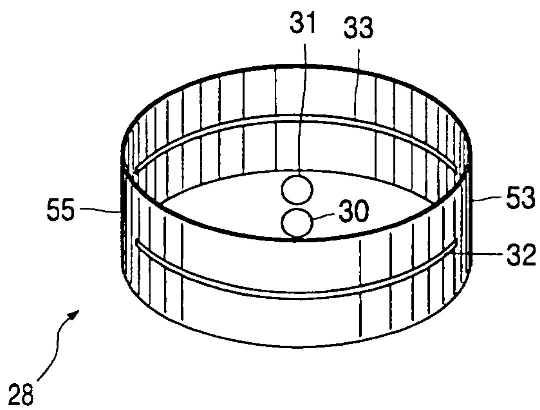


FIG. 4C

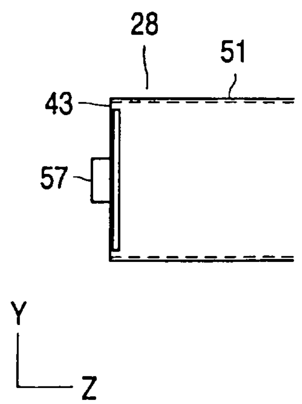


FIG. 5A

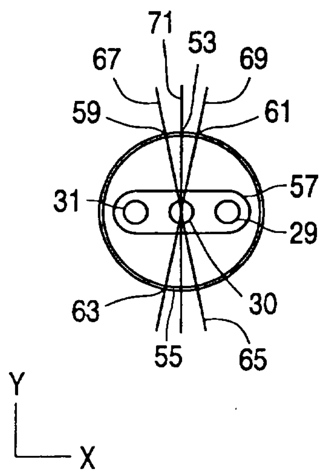


FIG. 5B

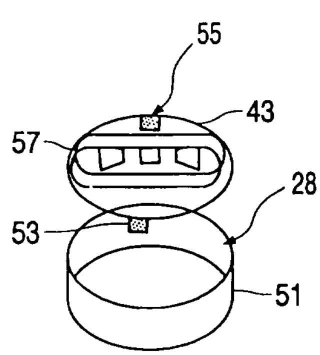


FIG. 5C

4/5

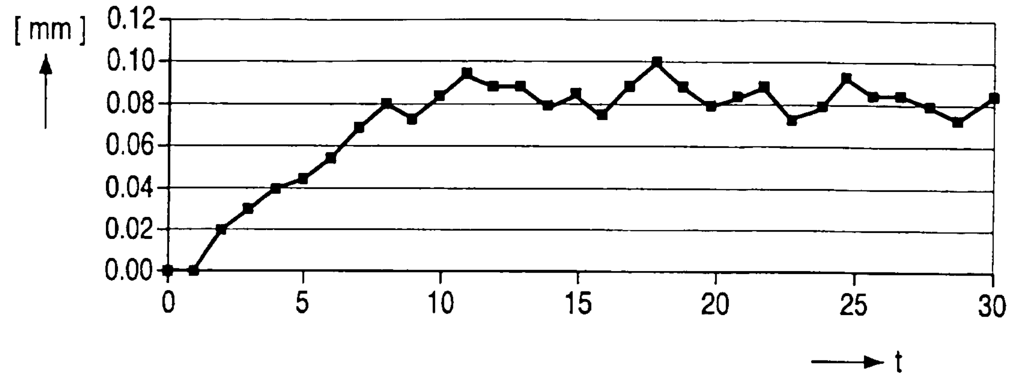


FIG. 6A

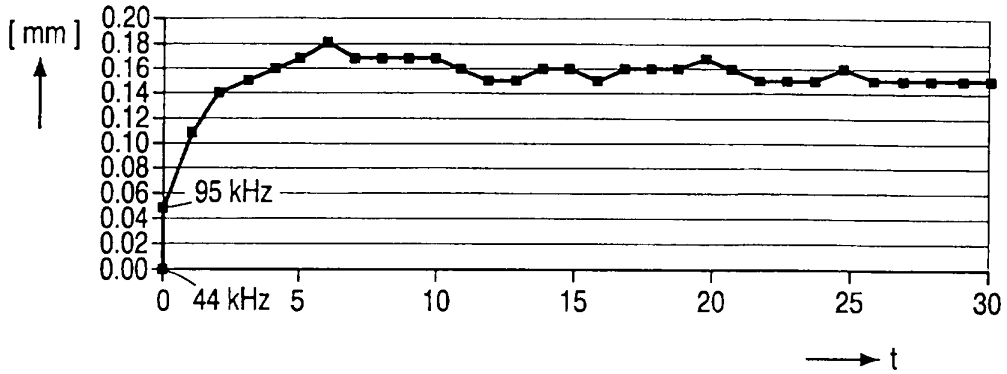


FIG. 6B

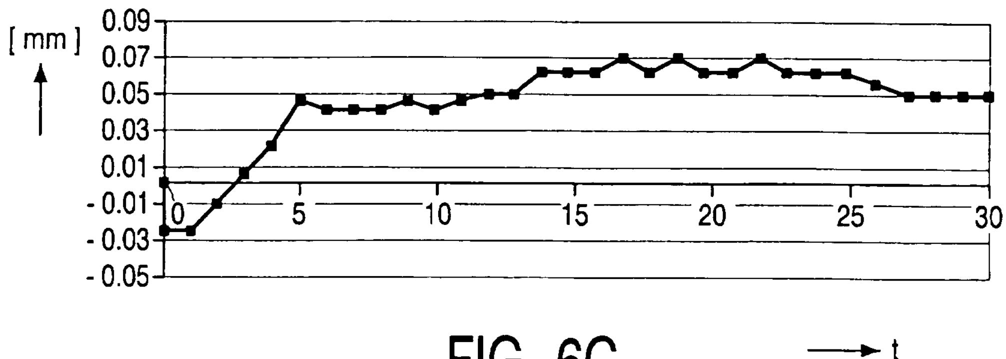


FIG. 6C

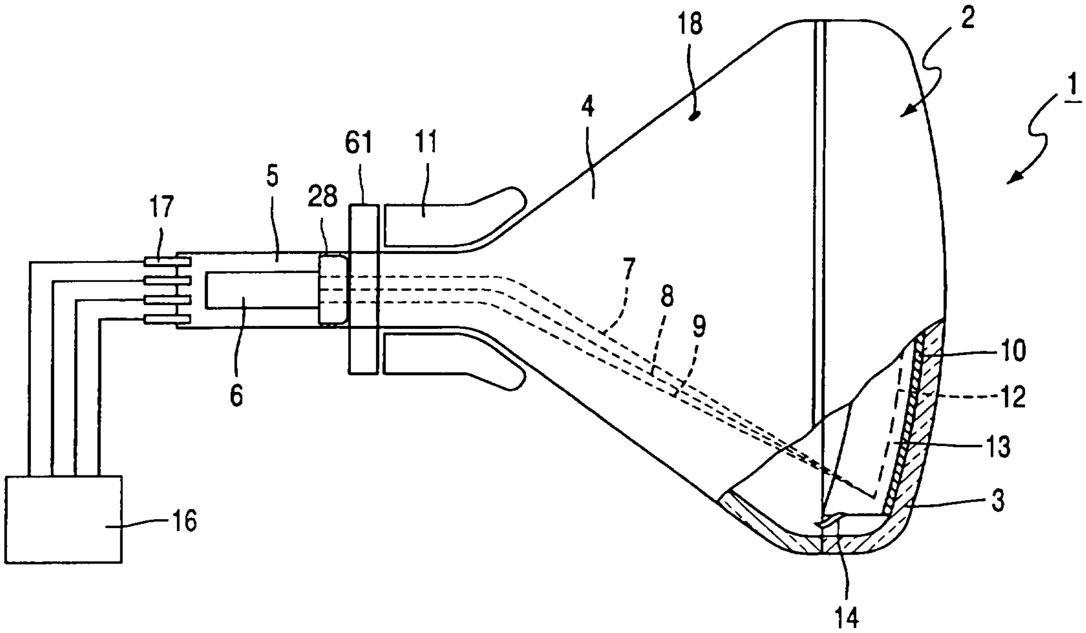


FIG. 7